Final Measurement and Verification Report for I&T Trial Project

Smart and Green Energy Storage System

I&T Project No. : P-0007
I&T Wish No. : W-0124
I&T Solution No. : S-0017

E&M InnoPortal

EMSD

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Purpose of the Project and Target Deliverables

This project was sponsored by ITF Public Service Trial Scheme (PSTS). The objective of PSTS is to strengthen the local start-up ecosystem, the funding scope of the ITF has been extended to cover production of prototypes/samples and/or conducting of trials in the public sector by incubatees and graduate tenants of HKSTPC and Cyberport.

Mission critical lighting of Highways Department (HyD) requires safe & reliable Uninterruptible Power System (UPS) as power backup solution, to protect it from any power interruptions. It is important to ensure zero downtime since drivers' safety is paramount. If lights go off at the underpass, the underpass will become a very hazardous driving environment

Due to limited public space available, outdoor plant room housing the power equipment & UPS has very tight space, also very high operating temperature especially for nonshaded sites during summer time. Current UPS solution uses VRLA (lead acid) batteries, which is very bulky taking up lots of space, and they tend to degrade rapidly under high operating temperature, hence shortening product lifespan calling for frequent replacements. Lead acid batteries are terrible polluters to the environment; Hong Kong produces over 20 million kilograms of waste lead acid batteries each year.

The Ampd Silo is a UPS solution for Highways Department Lighting Systems. This trial was as a proof of concept and verification of R&D outcomes.

The features of this solution includes:

i) Li-ion UPS

- compact small footprint

- high temperature resilience

- extended run-time

- little maintenance

ii) Web-based, central monitoring for critical facilities

- remote monitoring via SNMP, SIM card

- central dashboard

- service alerts via SMS

iii) Energy storage: Time shifting & Peak shaving (smart city applications)

Project Description

Firstly, Ampd purchased the materials required to build 3 x Ampd Silo P3 prototypes. After the prototypes were built, the finished units went through a Factory Acceptance Test (FAT) before delivery to Hung Hom site. Once delivered to site, Site Acceptance Test (SAT) will be conducted with actual load. After passing both the FAT & SAT, the three prototypes were installed at site to:

- replace current 40kVA Reillo UPS (with VRLA batteries) by 3 x Ampd Silo P3 (with Lion batteries)

- Ampd staff has collected operational data, conduct health check, gather any blackout/brownout data using power analyzer, to confirm Silo providing backup power seamlessly during power interruptions during the trial period of 4 months.

Trial Site

EMSD had proposed 4 Highways Department sites which are suitable for the PSTS trial. After several joint site visits and detailed discussion with HyD, all three parties unanimously selected and the Hung Hom Underpass Lighting site as the most suitable site for the trial. The equipment had installed in Hung Hom Underpass

Lighting Control Room (near Harbourview Horizon).

Type of Equipment/ Installation/ Technology Adopted

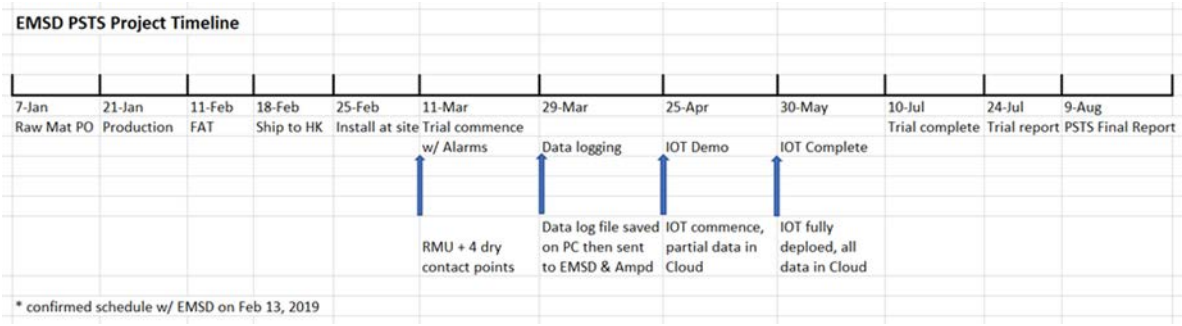
3 Ampd Silo P3s were used as Uninterruptible Power Supply for Highways Department's Hung Hom Underpass Lighting site (EMSD managed site), with a "2+1" configuration providing redundancy & extra protection.

The Ampd Silo is a next-generation single-cabinet lithium-ion UPS system for mission critical systems in commercial, enterprise and light industrial applications.

The Ampd Silo uses the latest 'third-generation' lithium-ion batteries, resulting in class-leading performance (data is provided by the solution provider):

- 90% lower OPEX: Eliminate battery replacements with the Ampd Silo's 'EnerCore' battery system, designed with a 10+ year service life.
- Less maintenance: All routine maintenance on the Ampd Silo is performed by its advanced Battery Management System (BMS), which monitors 504 parameters each second.
- high-temperature performance: The Ampd Silo's unique cooling system allows continued operation at ambient temperatures of up to 40 °C. No air-conditioning required.
- Unique 'Inherently Safe' design: The Ampd Silo's 'EnerCore' batteries are proven (in independent, third-party testing) to not only prevent, but also contain and control lithium-ion battery explosions.
- <10 kPa floor loading: The Ampd Silo's 'EnerCore' batteries are relatively light, resulting in a floor loading of under 10 kPa.
- 1,600 kg reduction in lead battery waste: the Ampd Silo's 'EnerCore' batteries have long lifetimes, each Ampd Silo removes 1,600 kg of toxic lead battery waste from the lead ecosystem.

Trial Timeframe



Name and Background of I&T Solution Provider

Ampd Energy (start-up) is a manufacturer of large, lithium-ion energy storage system. Founded in late 2014 to solve a global problem - unreliable power, which affects 3 billion people and millions of enterprises, the ability to do business and is a developmental impediment for countries. Unreliable power costs the businesses it affects as much as 35% of their sales revenue.

Details of Implemented Trials

I. Methodology and Applicable Standards

Using Lithium-ion batteries cells (UL1642, IEC 62133:2012) to form an energy module (UL1973 in progress) and storage system and convert back to mains supply as Uninterruptible Power Supply system for EMSD site – Highways Dept Hung Hom Underpass Lighting.

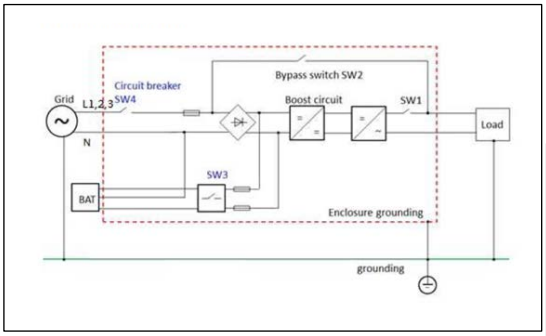
Photo 1. Ampd Energy System

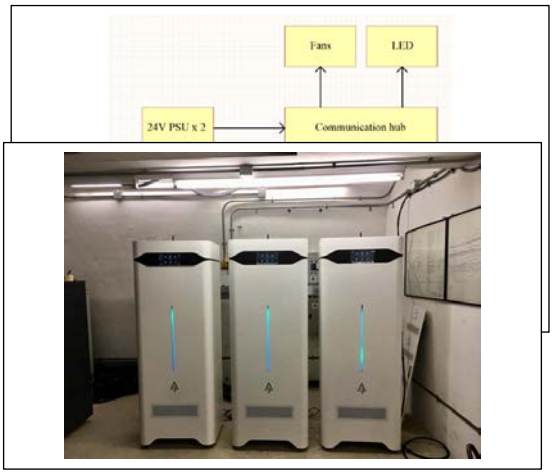
Photo 2. Hung Hom South Rd Underpass

Graph 1. Ampd Silo P3 on grid and load

Graph 2. Ampd Silo P3 Block Diagram

II. Measurement and Verification Activity Details





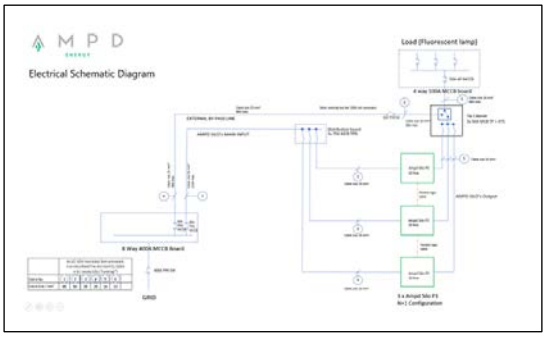
The Uninterruptible Power Supply system consists of three Ampd Silo P3 system installed for Highways Dept Hung Hom Underpass Lighting.

Photo 3. Old 40 kVA Reillo UPS

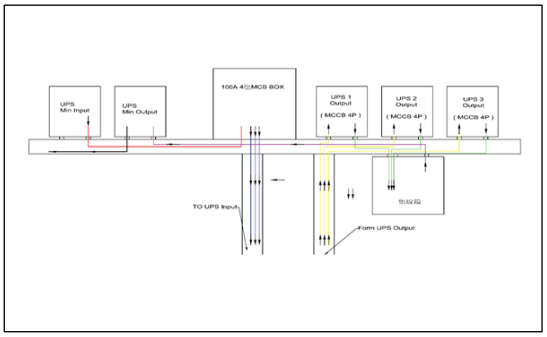
Photo 4. Ampd Silo P3 system

EMSD has advised Ampd a lot of input / advice in the area of Factory & Site Acceptance Test, local regulation requirement and Operation & Maintenance requirement. The Factory Acceptance Test (FAT) was used to verify the main design functions and ratings of the Ampd Silo P3 before delivery, prior to shipping the products from Dongguan factory to Hong Kong, Key objective is to verify design and performance as declared by the supplier Ampd Energy.

Silo P3 (Equipment Under Test, EUT has a parallel function that needs to be tested. However, each EUT needs to be tested independently at first instant and Battery mode, and connected in parallel and tested. Please refer the test result in AMPD P3 FAT (EMSD) V1.2.pdf.



Graph 3. Electrical Schematic Diagram



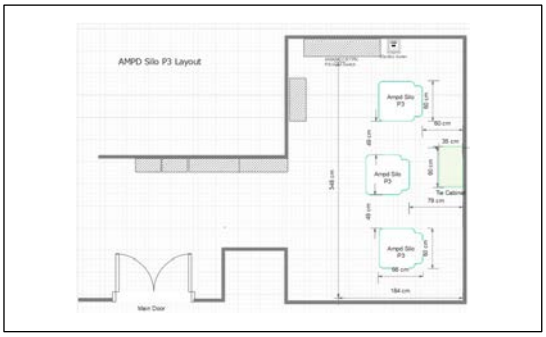
Graph 4. Electric wiring diagram

The installation of the Ampd Silo P3 system was on 8 March 2019. Both Comm Board and LCD had been updated simultaneously. Performance power on test for 3 Silo P3 had been tested. Performance in parallel test 3 x Silo P3 had been checked on 11 March 2019 with Internet of Things (IoT) and Remote Monitoring Unit (RMU) installed.

Photo 5. Electrical Wiring

Photo 6. Electric wiring (Completed)

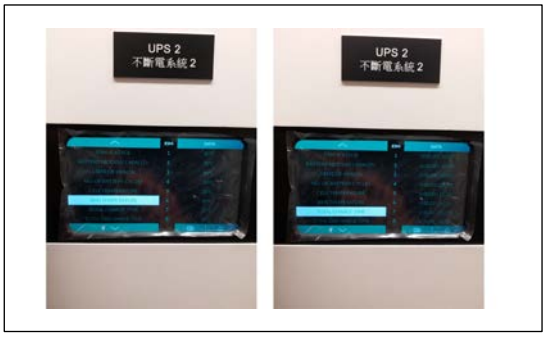
The Site Acceptance Test procedure was jointly prepared by AMPD and EMSD, to define the testing procedures and acceptance criteria of the AMPD SILO P3 regarding its installation at the Hung Hom site. The purpose of the SAT document is to define and record the on-site tests to demonstrate that the Silo P3s have been installed and tested in accordance with Ampd Energy's Technical Specifications, also, to account for specific tests as required by EMSD. Please refer the test result in SAT_P3 SAT for EMSD V1.1.pdf.



Graph 5. Equipment layout diagram

Graph 6. User Interface of Silo P3

Graph 7. Status and error checking



Graph 8. System temp & charge time

Summary Results and Analysis

I. Pre and Post-installation Comparison

The old 40 kVA UPS with external VRLA Batteries were replaced by 3 x 20 kVA Ampd Silo P3 UPS (2 + 1 configuration) with Lithium-Ion Battery built-in. Each Silo P3 UPS unit consists of 8 EnerCore battery modules.

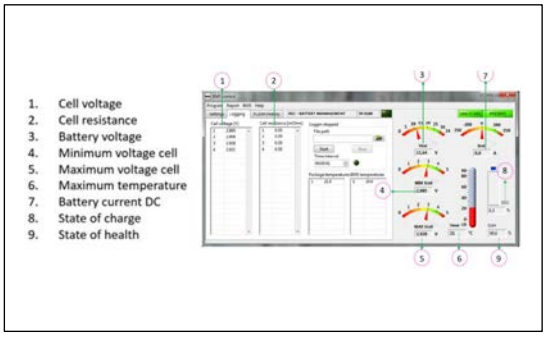
Ampd Silo has built-in Battery Management System (BMS) which monitors important performance data on real-time basis. In addition, the operating system of the Power Conversion System also reports vital data to ensure reliability & safety of the entire system.

In order to enable users to monitor Silo performance remotely, Ampd has developed the IoT platform to congregate all critical performance data in the cloud, for user to access via the internet any time they want (performance

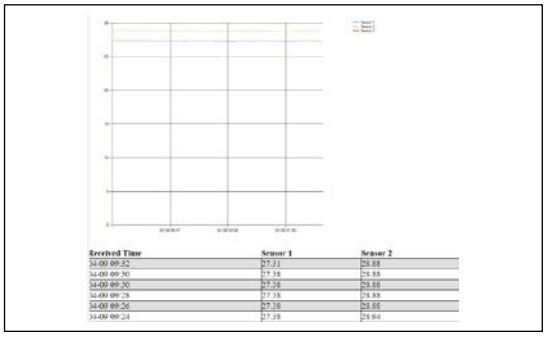
dashboard). The IoT platform provided crucial data to customers, which they can set alarms & alerts to be sent as per pre-defined conditions. It can reduce the cost & time required for any routine checking and maintenance.

II. Key Statistics/ Figures/ Infographics to Support the Results

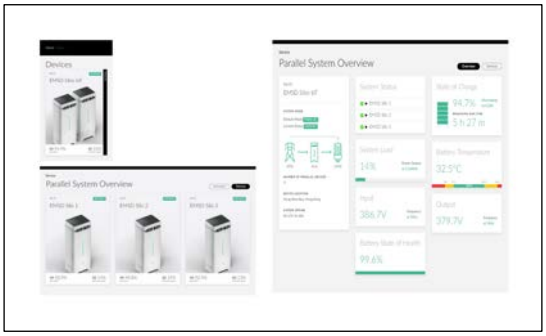
Environment data such as plant room inside temperature were measured by EMSD Remote Monitoring Units.



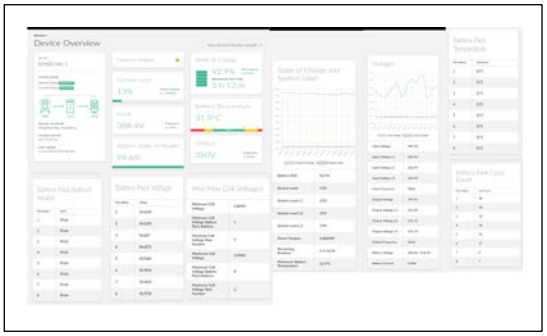
Graph 9. Battery Management system



Graph 10. Plant room inside temperature



Graph 11. Ampd Silo P3 status



Graph 12. Ampd Silo P3 status

III. Analysis of M&V Results to Address the Target Deliverables

The status of the Ampd Silo P3 installed at control room for HyD's Hung Hom Underpass Lighting site (EMSD managed site) can be monitor remotely through the link: http://iot-ampd.firebaseapp.com. There was no significant fault encountered and reported from Ampd Silo P3 system.

Conclusion and Way Forward

The results from the measurement and verification analysis indicated that the 3 x AMPD Silos installed have passed all the required Acceptance Tests, and the

performance data confirmed that Ampd Silo UPS system has delivered the backup solutions as per original plan. For the Time shifting and Peak shaving features, it requires a lot of programming resources and time to develop the algorithm, hence it has been scheduled for next round of major product upgrade.

- END OF REPORT -

Digitalisation and Technology Division

Electrical and Mechanical Services Department

11-Apr-2020

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